



Quality of acute myocardial infarction care in England and Wales during the COVID-19 pandemic: linked nationwide cohort study

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ABSTRACT

Background and objective The impact of the COVID-19 pandemic on the quality of care for patients with acute myocardial infarction (AMI) is uncertain. We aimed to compare quality of AMI care in England and Wales during and before the COVID-19 pandemic using the 2020 European Society of Cardiology Association for Acute Cardiovascular Care quality indicators (QIs) for AMI.

Methods Cohort study of linked data from the AMI and the percutaneous coronary intervention registries in England and Wales between 1 January 2017 and 27 May 2020 (representing 236 743 patients from 186 hospitals). At the patient level, the likelihood of attainment for each QI compared with pre COVID-19 was calculated using logistic regression. The date of the first national lockdown in England and Wales (23 March 2020) was chosen for time series comparisons.

Results There were 10 749 admissions with AMI after 23 March 2020. Compared with before the lockdown, patients admitted with AMI during the first wave had similar age (mean 68.0 vs 69.0 years), with no major differences in baseline characteristics (history of diabetes (25% vs 26%), renal failure (6.4% vs 6.9%), heart failure (5.8% vs 6.4%) and previous myocardial infarction (22.9% vs 23.7%)), and less frequently had high Global Registry of Acute Coronary Events risk scores (43.6% vs 48.6%). There was an improvement in attainment for 10 (62.5%) of the 16 measured QIs including a composite QI (43.8% to 45.2%, OR 1.06, 95% CI 1.02 to 1.10) during, compared with before, the lockdown.

Conclusion During the first wave of the COVID-19 pandemic in England and Wales, quality of care for AMI as measured against international standards did not worsen, but improved modestly.

guideline-indicated therapies such as invasive coronary angiography, timely reperfusion and secondary prevention medications improve survival,⁵ and professional organisations in the UK recommended the perpetuation of these therapies during the pandemic.^{6,7} Yet, an earlier study found an increase in 30-day mortality and a reduction in the proportion of invasive coronary angiography during the national lockdown for patients with non-ST segment elevation myocardial infarction (NSTEMI).⁸ There has been, however, no comprehensive evaluation of the quality of AMI care during the first national lockdown and no study has used recognised standards for such an investigation.

Quality indicators (QIs) have been increasingly used as a mechanism to measure broad aspects of care,⁹ identify unwanted variation^{10,11} and drive quality improvement.¹² For AMI, a suite of QIs exist which are valid,¹³ internationally recognised¹⁴ and have built on earlier indicators that have an inverse association with mortality.^{15–19} We used the UK national cardiovascular registries to investigate the quality of AMI care according to these indicators during the first national lockdown in the COVID-19 pandemic. This may help understand changes in the processes of AMI care during the time of national crisis and identify areas for improvement.

METHODS

Data and population

We used linked data from the UK national AMI and percutaneous coronary intervention (PCI) registries, namely the Myocardial Ischaemia National Audit Project (MINAP)^{20,21} and the National Audit

INTRODUCTION

The COVID-19 pandemic has impacted on the structure and organisation of services delivered through the National Health Service (NHS) with knock-on effects on the management of a number of acute cardiovascular conditions including acute myocardial infarction (AMI) in the UK.^{1–4} For patients admitted to hospital with AMI,



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of Percutaneous Coronary Intervention (NAPCI), championed by the British Cardiovascular Intervention Society.²² MINAP and NAPCI registries have been described previously.^{20 23} The National Institute for Cardiovascular Outcomes Research (NICOR), commissioned through the Healthcare Quality Improvement Partnership, manages MINAP, NAPCI and other registries.

NICOR has support under section 251 of the NHS Act 2006 (Ref: NIGB: ECC 1-06 (d)/2011) to use patient information for medical research without consent. Thus, ethical approval was not required under NHS research governance arrangements. We conducted our study in compliance with the Declaration of Helsinki using the MINAP and NAPCI databases.

Sample selection

We included all adult patients (≥ 18 years of age), discharged alive with ST-segment elevation myocardial infarction (STEMI) or NSTEMI from MINAP between 1 January 2017 and 27 May 2020. Data related to PCI were obtained from the NAPCI registry using each patient's unique NHS number to deterministically link patients between the two registries. Where multiple admissions for the same patient were recorded, the earlier admission was used to reduce potential bias from previous treatments. Patients with no valid NHS number were excluded.

Quality indicators

We used the 2020 European Society of Cardiology (ESC) Association for Acute Cardiovascular Care (ACVC) QIs for AMI, which comprise 26 indicators. The eligibility criteria for each QI was determined according to the specifications provided in the ESC ACVC document.¹⁴

Outcomes

The outcome was quality of AMI care. Care quality was quantified according to the degree to which eligible patients received the care outlined in the QIs prior to, compared with after, 23 March 2020 (up to 27 May 2020). This date was chosen for the time series comparison because it corresponded with the first national lockdown in England and Wales.

Statistical analysis

Patient baseline characteristics, comorbidities and treatments were reported according to the study period and type of AMI as percentages and numbers for categorical variables, means and SDs for parametric continuous variables, and medians and IQRs for non-parametric variables. Baseline differences between each diagnosis were tested using χ^2 test for categorical variables, t-test for continuous parametric and the Mann-Whitney U test for non-parametric variables. At the patient level, the likelihood of attainment for each QI compared with that before the COVID-19 pandemic was estimated using logistic regression.

All analyses were performed on complete cases. All tests were two-sided, and statistical significance was considered as p value < 0.05 . Statistical analyses were performed in Stata IC V.14.2 and R V.3.4.3.

RESULTS

Study population

Data for 236 743 patients admitted with AMI to one of 186 NHS hospitals were included. Of those, 152 109 (64.3%) patients had NSTEMI, and the median age was 69.0 (58–79) years with 75 918 (32.2%) patients being women. The cohort following lockdown (10 749) were compared with the period chosen before lockdown (225 994). [Table 1](#) shows the demographics, comorbidities, in-hospital treatment and discharge details according to the study period. Data are presented according to the type of AMI in online supplemental table 1. Compared with before the lockdown, patients admitted with AMI during the first wave had similar age (mean 68.0 vs 69.0 years), similar baseline characteristics (history of diabetes (25% vs 26%), renal failure (6.4% vs 6.9%), heart failure (5.8% vs 6.4%) and previous myocardial infarction (22.9% vs 23.7%)) and less frequently had high Global Registry of Acute Coronary Events (GRACE) risk scores (43.6% vs 48.6%) ([table 1](#)).

Quality of care assessment

Data from the national registries enabled the direct measurement of 16 (61.5%) of the 26 ESC ACVC QIs. The QIs that could not be assessed included the planned duration of dual anti-platelet therapy, the QIs within the patient satisfaction domain and the objective risk-stratification using validated tools. GRACE risk scores, however, were indirectly derived for 193 177 (81.6%) patients. In addition, while participating in a network for STEMI management, taking part in a registry and routine monitoring to reperfusion times in STEMI could not be directly measured, these form part of routine practice in the UK. The outcome QI (30-day mortality) may be obtained from data linkage with the Civil Registration of Deaths Register, but was not evaluated for this work because mortality had been previously investigated⁸ and this study concerned processes of care.

Quality of care during the COVID-19 pandemic

During, compared with before, the national lockdown, in England and Wales there was an improvement in attainment for 10 (62.5%) QIs, with evidence for a slight reduction in attainment for the other QIs that could be measured using the datasets ([table 2](#)). [Figure 1](#) shows the OR for QI attainment during the lockdown referenced to the pre-COVID period.

Overall, there was a slight increase in attainment for the composite QI after the first national lockdown (43.8% to 45.2%, OR 1.06, 95% CI 1.02 to 1.10) suggesting good overall adherence to

Table 1 Baseline characteristics for admissions with AMI, by study period

	Before lockdown	Since lockdown	All	Missing data % (n)
Patients, n	225 994	10 749	236 743	
Hospitals, n	186	186	186	
Demographics				
Female, % (n)	32.2 (72 667)	30.3 (3 251)	32.2 (75 918)	0.3 (621)
Age (years), median (IQR)	69.0 (58–79)	68.0 (58–77)	69.0 (58–79)	0 (0)
Baseline characteristics				
Heart rate at hospitalisation (bpm), median (IQR)	77 (66–90)	77 (66–90)	77 (66–90)	3.4 (7960)
Systolic blood pressure (mm Hg), median (IQR)	137 (120–156)	140 (121–160)	137 (120–157)	3.3 (7826)
Initial creatinine, $\mu\text{mol/L}$, median (IQR)	85 (71–105)	83 (70–101)	85 (71–104)	4.6 (10 824)
Diagnosis				
STEMI	35.7 (80 564)	37.9 (4070)	35.8 (84 634)	0 (0)
NSTEMI	64.4 (145 430)	62.1 (6679)	64.3 (152 109)	0 (0)
GRACE				
Score, median (IQR)	121 (96–151)	117 (95–143)	121 (96–151)	18.4 (43 566)
Low, % (n)	19.1 (35 628)	21.4 (1863)	19.4 (37 491)	
Intermediate, % (n)	32.1 (59 278)	35.0 (3049)	32.3 (62 327)	
High, % (n)	48.6 (89 563)	43.6 (3796)	48.3 (93 359)	
Killip class				
I, % (n)	82.3 (166 682)	85.5 (8263)	82.4 (174 945)	10.4 (24 511)
II, % (n)	11.4 (23 106)	9.3 (895)	11.3 (24 001)	
III, % (n)	4.6 (9320)	3.6 (348)	4.6 (9668)	
IV, % (n)	1.7 (3459)	1.7 (159)	1.7 (3618)	
Comorbidities				
Diabetes, % (n)	26.0 (58 767)	25.0 (2685)	26.0 (61 452)	0 (0)
COPD, % (n)	14.8 (33 539)	15.6 (1568)	14.8 (35 107)	0 (0)
Chronic heart failure, % (n)	6.4 (14 453)	5.8 (623)	6.4 (15 076)	0 (0)
Chronic renal failure, % (n)	6.9 (15 646)	6.4 (684)	6.9 (16 330)	0 (0)
Cerebrovascular disease, % (n)	7.3 (16 436)	6.5 (696)	7.2 (17 132)	0 (0)
Peripheral vascular disease, % (n)	4.0 (9109)	3.8 (409)	4.0 (9518)	0 (0)
Hypertension, % (n)	47.6 (107 532)	46.7 (5016)	47.5 (112 548)	0 (0)
Previous MI, % (n)	23.7 (47 647)	22.9 (2145)	23.7 (49 792)	11.3 (26 692)
Previous angina, % (n)	20.7 (40 919)	18.3 (1683)	20.6 (42 602)	12.7 (30 083)
Previous PCI, % (n)	15.4 (30 483)	16.3 (1499)	15.5 (31 982)	12.6 (29 742)
Previous CABG, % (n)	7.2 (14 324)	6.6 (610)	7.2 (14 934)	12.5 (29 565)
In-hospital procedures				
Invasive coronary angiography, % (n)	71.3 (160 795)	73.1 (7841)	71.3 (168 636)	0.15 (354)
PCI, % (n)	51.4 (116 202)	56.7 (6094)	51.7 (122 296)	0 (0)
CABG, % (n)	2.0 (4610)	0.9 (96)	2.0 (4706)	0 (0)
Medications at discharge				
Aspirin, % (n)	97.9 (167 286)	98.0 (7994)	97.9 (175 280)	24.4 (57 682)
P2Y ₁₂ inhibitor, % (n)	96.6 (165 723)	97.7 (8062)	96.6 (173 785)	24.0 (56 849)
Beta blocker, % (n)	96.1 (156 943)	96.5 (7557)	96.1 (164 500)	27.7 (65 590)
ACEi or ARB, % (n)	94.2 (148 284)	94.5 (7275)	94.2 (155 559)	30.3 (71 643)
Statins, % (n)	97.3 (168 402)	97.6 (8118)	97.3 (176 520)	23.5 (55 639)
Lifestyle advice				
Cardiac rehabilitation, % (n)	88.8 (159 999)	88.4 (7652)	88.8 (167 651)	20.2 (47 903)
Smoking cessation advice, % (n)	74.6 (48 821)	78.1 (2320)	74.6 (51 141)	71.1 (168 331)
Dietary advice, % (n)	89.8 (148 959)	91.1 (7067)	89.8 (156 026)	26.6 (63 013)

ACEi, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; bpm, beats per minute; CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; GRACE, Global Registry of Acute Coronary Events; MI, myocardial infarction; NSTEMI, non-ST segment elevation myocardial infarction; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.

Table 2 Quality indicator attainment before and during the COVID-19 pandemic for admissions with AMI

QI (receipt or availability)	Before lockdown (n=225 994)	After lockdown (n=10 749)	All (n=236 743)	P value
Hospital use of hs-cTn for NSTEMI, % (n)	70.4 (99 983)	82.1 (5403)	70.9 (105 386)	<0.001
Pre-hospital interpretation of ECG for STEMI, % (n)	76.6 (55 274)	80.7 (2696)	76.7 (57 970)	<0.001
Reperfusion among eligible for STEMI, % (n)	80.6 (64 931)	80.3 (3268)	80.6 (68 199)	<0.001
Timely reperfusion for STEMI, % (n)	80.1 (52 024)	79.8 (2608)	80.1 (54 632)	<0.001
Invasive coronary angiography within 24 hours for NSTEMI, % (n)	35.1 (24 208)	49.1 (1811)	35.8 (26 019)	<0.001
Radial access for invasive procedures, % (n)	87.6 (87 880)	91.4 (3924)	87.8 (91 804)	<0.001
Median time (min) from ECG to arterial access* for STEMI, median (IQR)	87.4 (65.5–118.0)	91.8 (70.0–131.1)	87.4 (65.5–120.1)	0.017
LVEF assessment before hospital discharge, % (n)	62.3 (140 848)	61.6 (6621)	62.3 (147 469)	<0.001
In-hospital measurement of LDL-C†, % (n)	56.0 (126 619)	61.5 (6613)	56.3 (133 232)	<0.001
Adequate P2Y ₁₂ inhibition on discharge, % (n)	96.6 (165 723)	97.7 (8062)	96.6 (173 785)	<0.001
Parenteral anticoagulation, % (n)	82.9 (147 369)	82.6 (6564)	82.9 (153 933)	<0.001
Dual antiplatelet therapy on discharge, % (n)	95.5 (156 034)	96.7 (7624)	95.5 (163 658)	<0.001
High-intensity statin on discharge‡, % (n)	97.3 (168 402)	97.6 (8118)	97.3 (176 520)	<0.001
ACEi for patients with reduced LVEF, % (n)	96.7 (45 542)	96.5 (2179)	96.7 (47 721)	<0.001
Beta blockers for patients with reduced LVEF, % (n)	98.1 (48 352)	98.3 (2260)	98.1 (50 612)	<0.001
Composite all-or-none, % (n)	43.8 (98 968)	45.2 (4863)	43.9 (103 831)	<0.001

*Door to balloon time.

†Serum cholesterol.

‡Discharged on statin.

ACEi, angiotensin converting enzyme inhibitor; AMI, acute myocardial infarction; hs-cTn, high-sensitivity cardiac troponin; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; NSTEMI, non-ST segment elevation myocardial infarction; QI, quality indicator; STEMI, ST-segment elevation myocardial infarction.

guidelines-indicated therapies for AMI during the COVID-19 pandemic.

DISCUSSION

This real-world naturalistic study evaluated the quality of AMI care in England and Wales before and during the COVID-19 pandemic using routinely collected nationwide registry data. We found that the NHS provided high-quality AMI care during the pandemic as measured against international standards. In particular, we found that early detection and timely invasive investigation for NSTEMI were delivered at much higher rates, while STEMI reperfusion was slightly delayed than prior to the UK lockdown. Such insights were gained by means of routinely collected cardiovascular data. These findings highlight the role that the UK national cardiovascular registries may play in the evaluation of processes of AMI care in times of need.

Others have described changes in the patterns of treatment for patients with AMI during the COVID-19 pandemic,^{1–3 8} but no study has quantified the breadth or depth of AMI care on a national level using validated QIs. Similar findings of an overall improvement in the quality of care have recently been reported for patients with stroke in the UK.²⁴ Taken together, this emphasises the consequences of a national crisis

on the delivery of processes of care for acute cardiovascular conditions and may help identify areas for improvement.

One may only speculate as to the reasons for improved care quality for AMI following the national lockdown. Given that there was a reported decline of between 16% and 40% in admissions with AMI to hospitals following the first UK lockdown, the modest improvement in attainment of the majority of the QIs during the pandemic could be explained by a relative increase in availability of cardiology staff and resources.^{1 2 8 25} That is, a reduction in admissions for AMI, with the maintenance of a specialist emergency heart attack service, would provide greater opportunities for specialist staff to deliver higher quality care.³ Indeed, at the time, the British Cardiovascular Society recommended the UK national heart attack service to continue as previously and not to revert to historical treatments for AMI such as thrombolysis.^{6 7} This was in contrast to recommendations during the early stages of the pandemic to adopt a ‘thrombolysis-first’ approach.²⁶ Given the decline in admissions with AMI, our findings suggest that care quality could be further improved with appropriate staffing and resources.

However, it is possible that other factors were at play. This includes the preparedness of dedicated services (and with this additional staff availability and attention) and the prioritisation of hospital discharges

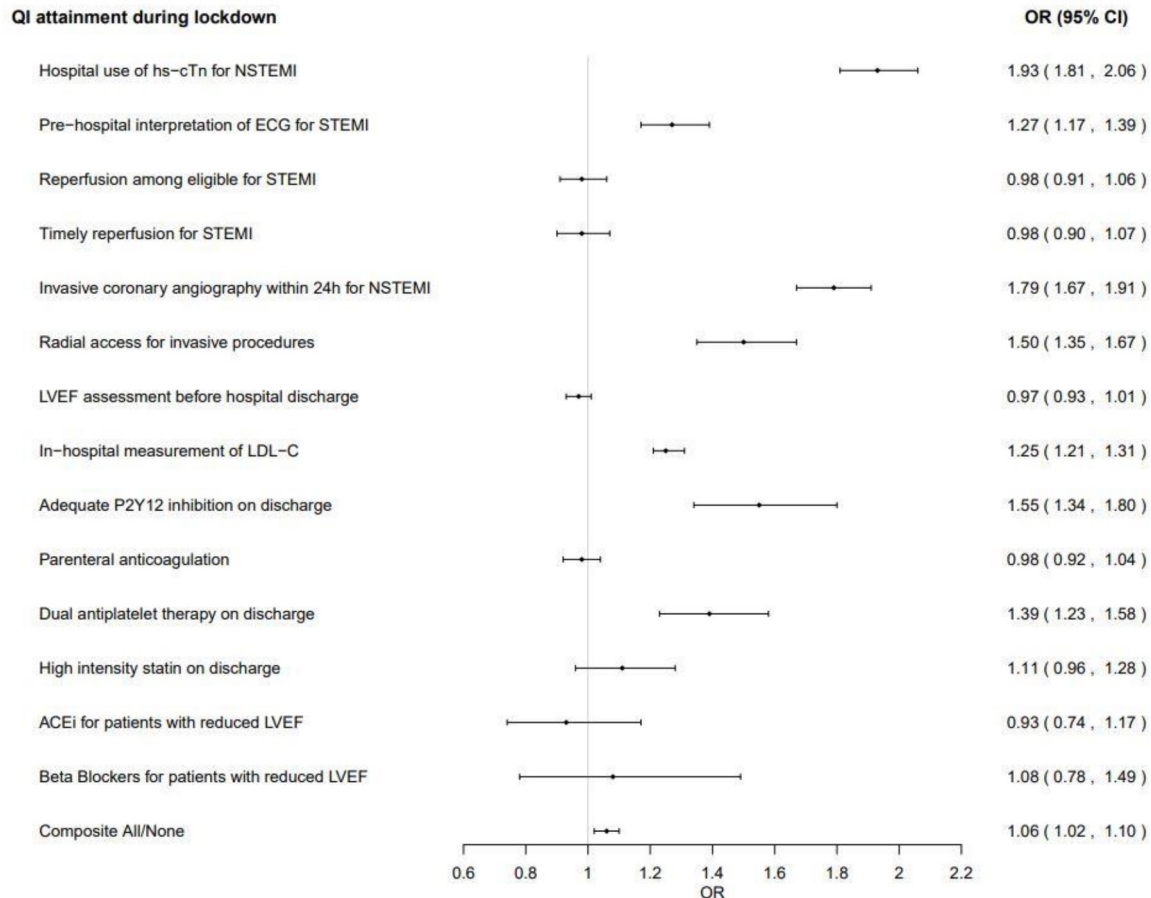


Figure 1 Quality indicator attainment for patients with AMI during the first UK national lockdown compared with the pre-COVID-19 period. ACEi, ACE inhibitor; AMI, acute myocardial infarction; DAPT, dual anti-platelet therapy; hs-cTn, high-sensitivity cardiac troponin; ICA, invasive coronary angiography; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; NSTEMI, non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction. Balloon inflation time was substituted for arterial access time, serum cholesterol for LDL cholesterol, and statin for high intensity statin.

(and therefore greater attention to the provision of care prior to leaving hospital).²⁷ Moreover, the ‘shut down’ of normal elective activity,^{28 29} which spanned all services, would have enabled the NHS to be better equipped to receive and treat patients with AMI. It is also plausible that the recording of data into the national registries was more selective, with a bias towards patients who were lower risk, had better care and who were more likely to be discharged alive (previous work has suggested that missing data is associated with 30-day mortality for STEMI and NSTEMI).³⁰

The delay in STEMI reperfusion observed in our study is consistent with other UK³ and international³¹ studies, and may be related to the changes to STEMI service during the pandemic including the redeployment of catheter laboratory staff to other intensive care environments.²⁷ Furthermore, the slight reduction in the assessment of left ventricular ejection fraction prior to hospital discharge and the prescription of angiotensin converting enzyme inhibitors or angiotensin receptor blockers for those with a reduced ejection fraction, as well as the increase in radial access use

after the lockdown, may be due to the fact that there was an imperative to make available hospital beds and therefore enable the early hospital discharge of stable patients following AMI.

Our study does emphasise an opportunity to integrate local efforts with those wider afield that aim to evaluate and improve the quality of AMI care. The ESC QIs have been designed to enable the assessment of care quality for AMI, according to international clinical practice guidelines.³² Equally, MINAP and NAPCI are used as tools for audit and evaluation of NHS heart attack services.³³ Hitherto, we were only able to measure 61.5% of the ESC AMI QIs against these two national registers. We propose that routine national data collection aligns to and harmonises with national and international standards for the measurement of quality of care.³⁴ Equally, we recognise that while information such as health-related quality of life may be difficult to capture via national registries,³⁵ greater alliance may help enhance the comprehensiveness of data collection systems in the UK.^{36 37}

Our study has limitations. MINAP does not collect information pertaining to all admissions with AMI

across the NHS.³⁸ It is possible that care quality for those admissions recorded were systematically different from those not in the registry. Nonetheless, MINAP does collect detailed clinical information pertaining to the majority of admissions in England and Wales with AMI, and is the largest single healthcare system AMI registry.²⁰ We substituted statin therapy for high-intensity statin, serum cholesterol for low-density lipoprotein cholesterol, and balloon inflation time for arterial access time. While these are slightly different aspects of care to the ones proposed in the ESC ACVC QIs, they provide insights into current practice of pharmacotherapy following AMI. This was a retrospective cohort study which has bias inherent to its observational design.

CONCLUSION

The COVID-19 pandemic created a natural experiment for the NHS. During this period, quality of care for AMI as measured against international standards did not worsen, but improved modestly. Given the decline in admissions with AMI, our findings could suggest that care quality may be further improved with appropriate staffing and resources. Implicit in the study is the notion that routinely collected data in concert with standardised measures of care quality allow appropriate evaluation of care quality.

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